Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Service Rules and Procedures to Govern the	)	IB Docket No. 05-20
Use of Aeronautical Mobile Satellite Service	)	
Earth Stations in Frequency Bands	)	
Allocated to the Fixed Satellite Service	)	

REPLY COMMENTS OF THE BOEING COMPANY

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SUMMARY

The Boeing Company ("Boeing") strongly supports the Commission's efforts to facilitate the provision of innovative broadband aeronautical communications services to aircraft passengers and crew, while at the same time protecting other authorized users of the spectrum, through the adoption of comprehensive service and licensing rules. The comments submitted in this proceeding universally recognize the benefits of the Ku-band Aeronautical Mobile-Satellite Service ("AMSS"). Boeing urges the Commission to adopt rules for Ku-band aircraft earth station ("AES") operations consistent with Boeing's comments in this proceeding and these reply comments (including the revised AMSS rules attached hereto).

In particular, similar to its regulation of Ku-band VSATs and earth stations onboard vessels ("ESVs"), the Commission should adopt rules that (i) apply AMSS off-axis e.i.r.p. limits as aggregate limits for simultaneously transmitting AESs; (ii) provide Ku-band AMSS system operators with the flexibility to coordinate AES transmissions in excess of the standard off-axis e.i.r.p. values, subject to an additional technical showing and the rights of future U.S. Ku-band licensees to require compliant operations in certain circumstances; (iii) start the off-axis e.i.r.p. density mask at 1.5° (or 2° for systems that take pointing error into account in calculating off-axis e.i.r.p.); and (iv) allow for the short-term exceedance of the off-axis e.i.r.p. mask and minor variations due to antenna performance.

The Commission, however, should not impose a specific pointing accuracy requirement on Ku-band AMSS licensees because it would unnecessarily constrain AMSS system development. In addition, while Boeing supports a requirement that Ku-band AMSS licensees be capable of providing AES identification, location and spectrum use information for interference resolution and enforcement purposes, Boeing strongly opposes the public

availability of AES tracking data and the involvement of third parties to facilitate interference resolution.

The Commission should also adopt uniform AMSS requirements for AES operators serving both U.S. and non-U.S. registered aircraft in the United States. In this regard, the Commission should retain full authority to substantively review and authorize all AES operations within U.S. airspace, including those provided using hub earth stations or network control facilities located outside the United States.

Finally, Boeing recognizes the importance of developing appropriate capabilities to address law enforcement and national security concerns in the context of providing AMSS services, and agrees with the Department of Justice, the Federal Bureau of Investigation and the Department of Homeland Security (collectively, "the Departments") that all reasonable remedial measures should be taken to eliminate or minimize these concerns. Given the unique network architecture of individual AMSS systems, Boeing believes that a limited number of system-specific agreements, rather than rules of general applicability, are the optimal means to ensure that the needs of law enforcement are met. Boeing intends to continue working with the Departments to reach appropriate understandings in regard to their legitimate law enforcement, public safety and national security requirements.

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REPLY COMMENTS OF THE BOEING COMPANY

The Boeing Company ("Boeing") hereby submits its reply comments in the above-captioned proceeding regarding the adoption of service rules and procedures governing the operation and licensing of aircraft earth stations ("AESs") in the Aeronautical Mobile-Satellite Service ("AMSS") operating in the Ku-band Fixed-Satellite Service ("FSS") frequencies.[1] As discussed in its initial comments, Boeing strongly supports the Commission's efforts to facilitate the provision of innovative broadband aeronautical communications services to aircraft passengers and crew, while at the same time protecting other authorized users of the spectrum.[2]

I. INTRODUCTION

As the leading proponent of advanced broadband satellite communications services for commercial, government and private aircraft customers through its Connexion by Boeing[SM] ("Connexion") service offering, Boeing is pleased to observe that the comments submitted in this proceeding universally recognize the benefits of Ku-band AMSS services and support the

[1] Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service, *Notice of Proposed Rulemaking*, 20 FCC Rcd 2906 (2005) ("*NPRM*").

[2] *See generally* Comments of The Boeing Company, IB Docket No. 05-20 (filed July 5, 2005) ("Boeing Comments").

adoption of comprehensive AMSS licensing and service rules. Most commenters also generally support the proposals suggested by Boeing in its draft rules.

For example, commenters agree that blanket licensing of AESs is the most efficient licensing method.[3] Other flexible and pro-competitive proposals such as the availability of ALSAT authority for Ku-band AMSS operations also received broad support because they will promote further development of AMSS services.[4] In all cases, the Commission should ensure that the "requirements imposed on AES operators to obtain licenses under the new system are not unduly burdensome … and should be consistent with…. current rules."[5]

Boeing urges the Commission to expeditiously adopt an AMSS regulatory regime consistent with Boeing's comments in this proceeding and these reply comments. Prompt implementation of AMSS licensing and service rules will serve the public interest by facilitating access to new and innovative aeronautical communications services without regulatory uncertainty or delay.

II. DISCUSSION

In its initial comments, Boeing has proposed a comprehensive set of rules to govern Ku-band AMSS services modeled on the Commission's rules for earth stations onboard vessels ("ESVs"), with several important changes made to reflect recently adopted or proposed changes

[3] *See* Comments of Telesat Canada, IB Docket No. 05-20, at 3 ¶ 12 (filed July 5, 2005) ("Telesat Comments") (stating that "licensing individual terminals is likely to be both impractical and unnecessary"). *See also* Comments of Intelsat, Ltd., IB Docket No. 05-20, at 6 (filed July 5, 2005) ("Intelsat Comments") (favoring adoption of blanket licensing).

[4] *See* Comments of ARINC, IB Docket No. 05-20, at 22-24 (filed July 5, 2005) ("ARINC Comments"); Boeing Comments at 35-36; Telesat Comments at 4 ¶ 13; Comments of ViaSat, IB Docket No. 05-20, at 20-21 (filed July 5, 2005) ("ViaSat Comments").

[5] *See* Comments of SES Americom, Inc., IB Docket No. 05-20, at 2 (filed July 5, 2005) ("SES Americom Comments").

to the VSAT rules made in the Commission's Part 25 streamlining proceeding.[6] In these reply comments, Boeing provides additional information regarding specific elements of the proposed AMSS rules and addresses certain issues raised by other commenters in this proceeding.

At the outset, Boeing notes that ViaSat has suggested that "the Commission should recognize AMSS as an application of FSS networks, and therefore should afford them primary status to the extent that AMSS is no more interfering than and no more susceptible to interference than a typical VSAT."[7] The Commission should give consideration to ViaSat's proposal.[8] Regardless of the regulatory status afforded to AMSS operations the Commission should adopt AMSS licensing and service rules consistent with those proposed by Boeing.

A. Off-Axis E.I.R.P. Density Limits

In its comments, Boeing demonstrated that an AES off-axis e.i.r.p. density mask that is closely aligned with the proposed VSAT mask will allow for greater flexibility in antenna design without increasing the potential for harmful interference into adjacent FSS satellites.[9] Commenters addressed a number of issues associated with the appropriate off-axis e.i.r.p. density mask for AMSS services and, in large measure, were supportive of the positions advanced by Boeing. In these reply comments, Boeing addresses the need for (i) aggregate AES limits; (ii) coordination of higher off-axis e.i.r.p. values; (iii) a revised starting angle for the off-axis e.i.r.p.

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[6] *See* Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands, *Report and Order*, 20 FCC Rcd 674 (2005) ("*ESV Report and Order*"); 47 C.F.R. § 25.222. *See also, e.g.,* 2000 Biennial Regulatory Review -- Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations, *Sixth Report and Order and Third Further Notice of Proposed Rulemaking*, 20 FCC Rcd 5593 (2005) ("*Sixth Report and Order*" or "*Third Further NPRM*").

[7] ViaSat Comments at 3.

[8] *Id. See also* Boeing Comments at 6-7.

[9] *See* Boeing Comments at 15-26.

mask; and (iv) short-term exceedance of the off-axis e.i.r.p. mask and minor variations due to antenna performance.

1. Aggregate AES Limits

In the *NPRM*, the Commission proposed that if an AMSS operator chooses to implement a modulation technique that permits multiple co-frequency AES transmissions terminals being simultaneously received at the same satellite, it would impose equal off-axis e.i.r.p. density limits on each individual AES by dividing the applicable limit by the number of simultaneously transmitting AESs.[10] As discussed in Boeing's initial comments, this proposal does not account for bandwidth-on-demand systems such as Connexion by Boeing[SM] ("Connexion") and thus would seriously undermine the existing operations and future development of AMSS systems in the United States.[11] The Connexion system varies the transmit power levels of individual AESs based on their capacity needs, providing true bandwidth-on-demand while ensuring that the aggregate off-axis e.i.r.p. density of all simultaneously transmitting AESs remain within prescribed limits to co-frequency FSS operations. Adopting static, individual AES off-axis e.i.r.p. density limits would foreclose advanced AMSS network management techniques such as those employed by the Connexion system and adversely affect Boeing's ability to service its many AMSS customers, including the U.S. Government. Accordingly, it is imperative that the Commission apply the AMSS off-axis e.i.r.p. limits as aggregate limits for simultaneously transmitting AESs.

[10] *See NPRM*, 20 FCC Rcd at 2926-27 ¶ 36. This proposal is identified here as the 10*Log(N) or individual limits approach.

[11] Boeing Comments at 21-22.

ARINC, Intelsat, SES Americom and ViaSat all agree that AMSS off-axis e.i.r.p. limits should be applied as aggregate limits and not applied on an individual AES basis.[12] SES Americom, for example, suggests that providing flexibility to AMSS operators is important for the development of AMSS networks and the opportunity to use dynamic power assignment will maximize the overall efficiency of AMSS systems.[13] In addition, ARINC notes the aggregate off-axis envelope adequately protects the FSS from harmful interference and that adoption of the aggregate mask is consistent with Recommendation ITU-R M.1643, which will further the Commission's licensing of AMSS stations consistent with the outcome of WRC-03.[14]

One of the main reasons the Commission suggested limits on individual AES terminals was that "enforcement and control of off-axis EIRP density limits on individual AES terminals might be simpler for [network control facilities] than controlling an aggregate value."[15] However, as ARINC points out, the sophisticated computer algorithms that are employed by some AMSS operators are perfectly capable of aggregating AES power levels across an entire AMSS network, ensuring compliance with the aggregate mask.[16] Furthermore, Boeing has been controlling aggregate off-axis e.i.r.p. of the Connexion system for a number of years without a single report of harmful interference.[17]

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[12] *See* ARINC Comments at 3-5; Intelsat Comments at 3; SES Americom Comments at 2-4; ViaSat Comments at 8-11.

[13] SES Americom Comments at 3.

[14] ARINC Comments at 3-4.

[15] *NPRM*, 20 FCC Rcd at 2926-27 ¶ 36. Telesat Canada espouses a similar position in its comments. *See* Telesat Comments at 3 ¶ 8.

[16] ARINC Comments at 4.

[17] SES Americom pointed out that, in its experience in providing capacity to AES system operators, it has found that AES terminals can be deployed without creating harmful interference for incumbent operations. SES Americom Comments at 2.

ViaSat also provides a clear description of the problems associated with imposing off-axis e.i.r.p. limits to individual terminals by using a 10*log(N) reduction factor when there are multiple co-frequency AES transmissions.[18] However, the alternative formula proposed by ViaSat (which illustrates the aggregation process by simply adding up the off-axis e.i.r.p. density of the individual AESs) appears overly simplistic and inappropriately limiting.[19] For example, it does not appear to take AES antenna mispointing into account.[20] The rules adopted by the Commission should be flexible enough to accommodate various AMSS system designs, so long as they ensure that the aggregate off-axis e.i.r.p. density limits are met. Thus, it appears the best approach is for the Commission to permit AMSS operators to apply off-axis e.i.r.p. density limits on either an individual *or* aggregate basis depending on the sophistication of their system design.

2. Coordination of Higher Off-Axis E.I.R.P. Values

Ku-band AMSS system operators, like VSAT operators, should have the flexibility to coordinate AES transmissions in excess of the off-axis e.i.r.p. values set forth in the Commission's rules, subject to an additional technical showing and the rights of future U.S. Ku-band licensees to require compliant operations in certain circumstances.[21] All of the parties addressing this issue believe that AMSS system operators should be able to operate in excess of

[18] ViaSat correctly notes that the individual limits approach simply has no flexibility to accommodate a variable data rate CDMA type network and it is overly simplistic and inefficient. *See* ViaSat Comments at 9-11.

[19] *Id.* at 11.

[20] As discussed below with respect to antenna pointing requirements, the mispointing of AES antennas is a random variable with a different effect on the aggregate off-axis e.i.r.p. density envelope, depending on the AES power level. This phenomenon needs to be taken into account in the aggregation algorithm.

[21] Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the 14-14.5 GHz Band to the Aeronautical Mobile-Satellite ("AMSS") and to Adopt Licensing and Service Rules for AMSS Operations in the Ku-Band, Petition for Rulemaking of The Boeing Company, at 15-16 (filed July 21, 2003) ("Petition"); Boeing Comments at 22-25.

the established off-axis e.i.r.p. limits subject to certain limitations.[22] SES Americom, for example, notes that this approach is already used for other types of satellite terminals that do not comply with the applicable e.i.r.p. standards and has the advantage of permitting adjacent operators to make individualized determinations regarding non-compliant operations.[23]

Intelsat and PanAmSat suggest that, in the case of U.S.-licensed satellites communicating with AESs at higher values, the serving satellite operator should be permitted to certify that the higher levels are consistent with coordination agreement with foreign satellite operators but that such certifications should be countersigned by neighboring U.S.-licensed satellite operators.[24] In this connection, PanAmSat argues that a single-party certification is of no value because it is unlikely there will be a coordination agreement in place between U.S. operators.[25] This suggestion misses the mark because in such circumstances the serving satellite operator could not certify that the higher-power AMSS operations are consistent with coordinated parameters and, therefore, a new coordination agreement would be required. Boeing believes that certifications from U.S. satellite operators are reliable regardless of whether the neighboring satellite is U.S. or foreign-licensed, and thus the Commission need not require a counter-signature. Given that AMSS licensing proceedings are subject to notice and public comment, and thus can be challenged by interested parties, a certification from the serving satellite operator should be more than sufficient to establish that the proposed AMSS operations are consistent with the satellite's coordinated parameters.

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[22] ARINC Comments at 6-7; Intelsat Comments at 5; Comments of PanAmSat, IB Docket No. 05-20, at 3-4 (filed July 5, 2005) ("PanAmSat Comments"); SES Comments at 4; Telesat Comments at 3 ¶ 10.

[23] SES Americom Comments at 4.

[24] Intelsat Comments at 5; PanAmSat Comments at 4-5.

[25] PanAmSat Comments at 4.

3. Starting Angle for the Off-Axis E.I.R.P. Mask

As discussed in Boeing's comments, starting the off-axis e.i.r.p. density mask at 1.5° (or 2° for systems that take pointing error into account in calculating off-axis e.i.r.p.) will afford AMSS operators needed flexibility without increasing the risk that neighboring FSS satellites will experience harmful interference. ViaSat and Intelsat agreed that the starting angle should start at no less than 1.5°.[26] As ViaSat points out, the Commission has already determined in the *Sixth Report and Order* that the antenna gain pattern for VSAT networks should start at 1.5° instead of 1.0°.[27]

As the Commission concluded, starting the antenna gain pattern envelope at a wider off-axis angle permits wider main lobes that are characteristic of smaller earth station antennas.[28] ViaSat correctly points out that adjacent satellites are adequately protected by the requirement to maintain orbital longitude within 0.05° of their assigned orbital location and are further protected by the additional safeguard against harmful interference resulting from the difference between geocentric angles (on which Part 25 VSAT limits are based) and topocentric angles (under which real-world earth station operations occur).[29] Thus, consistent with its conclusions in the *Sixth Report and Order*, the Commission should start the AES off-axis e.i.r.p. density mask at no less than 1.5°, just as is done for VSATs.

Further, as Boeing demonstrated in its comments, a strong case can be made for starting the mask at 2.0° rather than 1.5° for those systems that take into account AES antenna pointing

[26] ViaSat Comments at 4-5; Intelsat Comments at 3-4.

[27] ViaSat Comments at 5. *See also Sixth Report and Order*, 20 FCC Rcd at 5614 ¶ 49.

[28] *Sixth Report and Order*, 20 FCC Rcd at 5599 ¶ 12.

[29] ViaSat Comments at 5; *Sixth Report and Order*, 20 FCC Rcd at 5604 ¶ 22. The topocentric angle is always greater than the geocentric angle, and a 2.0° geocentric angle equates to a 2.1° to 2.2° topocentric angle, thereby providing an additional 0.1° to 0.2° margin of error.

error in calculating aggregate off-axis e.i.r.p. density levels.[30] These systems, such as Boeing's Connexion system, calculate the aggregate off-axis envelope taking into account the AES pointing error, and then compare this envelope to the VSAT off-axis e.i.r.p. mask criteria, which also takes into account earth station mispointing.[31] This approach essentially accounts for the AES antenna mispointing twice because it includes the mispointing in both the calculation of the off-axis e.i.r.p. envelope and in the mask to which it is compared. Accordingly, systems that take into account AES antenna pointing error in the calculation of the aggregate AES off-axis e.i.r.p. envelope should be allowed to use an off-axis e.i.r.p. density mask that starts at an offset angle of 2.0° rather than 1.5°. In doing so, AES mispointing would be taken into account only once, resulting in a more accurate mask that fully protects adjacent satellite operations.

PanAmSat, on the other hand, urges that the mask start at 1.0° to provide "additional assurance that adjacent satellites will be adequately protected."[32] PanAmSat provides no analysis to support its assertion,[33] and there is simply no basis for starting the mask at 1.0° because imposing limits between 1° and 1.5° (or 2° in certain circumstances) would provide no additional protection whatsoever to neighboring satellites that are nominally 2.0° away (and actually 2.2° away when viewed from the Earth's surface). Thus, PanAmSat's suggestion to start the mask at 1.0° should be rejected.

[30] Boeing Comments at 15-17.

[31] That is, in order to protect a satellite located 2° away from the target satellite, the proposed VSAT mask starts at 1.5° so as to account for possible antenna mispointing.

[32] PanAmSat Comments at 3.

[33] *See id.*

4. Short-Term Exceedance of the Off-Axis E.I.R.P. Mask and Minor Variations Due to Antenna Performance

The Commission proposed in the *NPRM* that, for angles greater than 7.0°, the AES off-axis e.i.r.p. density envelope may be exceeded by no more than 10 percent of the sidelobes, provided no individual sidelobe exceeds the envelope by more than 3 dB.[34] Boeing and other commenters agree. Intelsat notes that satellites licensed under the two-degree spacing rules already take into account the possibility of such limited variances and therefore they do not raise interference concerns.[35] Similarly, ViaSat and ARINC point to industry experience to suggest that minor variances should be allowed.[36]

In addition to potential exceedance caused by minor antenna variations, the Commission proposed in the *Third Further NPRM* a new contention protocol rule that would permit additional exceedances of extremely short duration for varying percentages of time based on the extent of the exceedance.[37] Boeing proposed extending this approach to Ku-band AESs employing multiple access techniques because allowing exceedances of extremely short duration (less than 100 ms each) for variable periods of time based on the extent of the exceedance adequately balances the need to protect adjacent satellite operators with the need for efficient operation of Ku-band AMSS systems.[38]

Permitting short-term exceedance of the off-axis e.i.r.p. mask is supported by the record developed in this proceeding. ViaSat explains that through the use of contention protocols, an AMSS operator can operate its system so that traffic bursts will arrive in a well-defined

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[34] *NPRM*, 20 FCC Rcd at 2927-28 ¶ 38.

[35] Intelsat Comments at 4.

[36] ViaSat Comments at 14; ARINC Comments at 6.

[37] *Third Further NPRM*, 20 FCC Rcd at 5635-37 ¶¶ 119-20.

[38] Boeing Comments at 18-20.

probability distribution, ensuring that the average number of AES terminals transmitting is such that interference within the network as well as the off-axis e.i.r.p. are within the prescribed limits even if AES terminals exceed the off-axis e.i.r.p. density mask for a short period of time.[39] The Commission has adopted contention protocols to allow VSAT operators to exceed the proposed off-axis e.i.r.p. envelope for a small percentage of time and, as ARINC contends, there is no rational basis to allow VSAT contention protocol systems to exceed the mask for statistically insignificant periods of time, but not also provide the same relief for AMSS operators.[40]

B. AES Antenna Pointing Accuracy

The Commission proposes to require an AMSS applicant to provide information demonstrating that it has accounted for factors in the design, coordination and operation of an AMSS system, including mispointing of AES antennas, variation in the antenna pattern of an AES and variations in the transmit e.i.r.p. density for the AES.[41] Boeing supports requiring Ku-band AMSS applicants to fully account for these factors, but disagrees with the Commission's proposal that AMSS licensees should maintain a pointing accuracy of 0.2º for all AESs within their licensed networks. As several commenters noted, imposing a uniform AMSS pointing accuracy requirement would unnecessarily constrain AMSS system development and deployment, and hinder the development of innovative technologies that could further guard against harmful interference.[42] Further, although the Commission suggests that such a requirement is consistent with the results reached at WRC-03, no pointing accuracy requirement

[39] ViaSat Comments at 12-14.

[40] ARINC Comments at 24-25.

[41] *NPRM*, 20 FCC Rcd at 2929-30 ¶ 41.

[42] ARINC Comments at 11-13; Boeing Comments at 27. *See also* ViaSat Comments at 19 ("pointing accuracy requirements would be overly burdensome").

was adopted for Ku-band AMSS systems at the Conference.[43] Thus, as noted by several commenters, unlike for ESV systems, adoption of a pointing accuracy requirement has no basis in ITU requirements governing AMSS systems and is inconsistent with the results reached at WRC-03.[44]

AMSS licensees will prevent harmful interference to FSS operations by controlling the overall power of the network to the specified off-axis e.i.r.p. density limits, regardless of the pointing error of AESs within their system.[45] Because accounting for antenna mispointing and meeting aggregate off-axis e.i.r.p. density limits eliminates the need for a pointing accuracy requirement, and because such a restriction would unduly constrain AMSS licensees and limit technical advancement, the Commission should decline to impose a specific AES pointing error requirement.

In its Technical Appendix, ARINC raises a number of constructive issues concerning the problems associated with a 0.2º pointing error restriction.[46] The graph provided by ARINC illustrates that the off-axis e.i.r.p. envelope produced by a single AES is well below the 15-25 log(θ) mask.[47] The ARINC graph does not, however, illustrate the very small effect of such a single mispointed AES on the aggregate emissions of a number of AESs. The following graph shows the off-axis e.i.r.p. envelope of a single typical AES, pointed perfectly, and a single AES that is shifted by 0.5º. It also shows the aggregate envelope of a system consisting of eight AESs as compared to the 15-25 log(θ) mask. Importantly, the aggregate curve shown is actually two

[43] *See* Recommendation ITU-R M.1643.

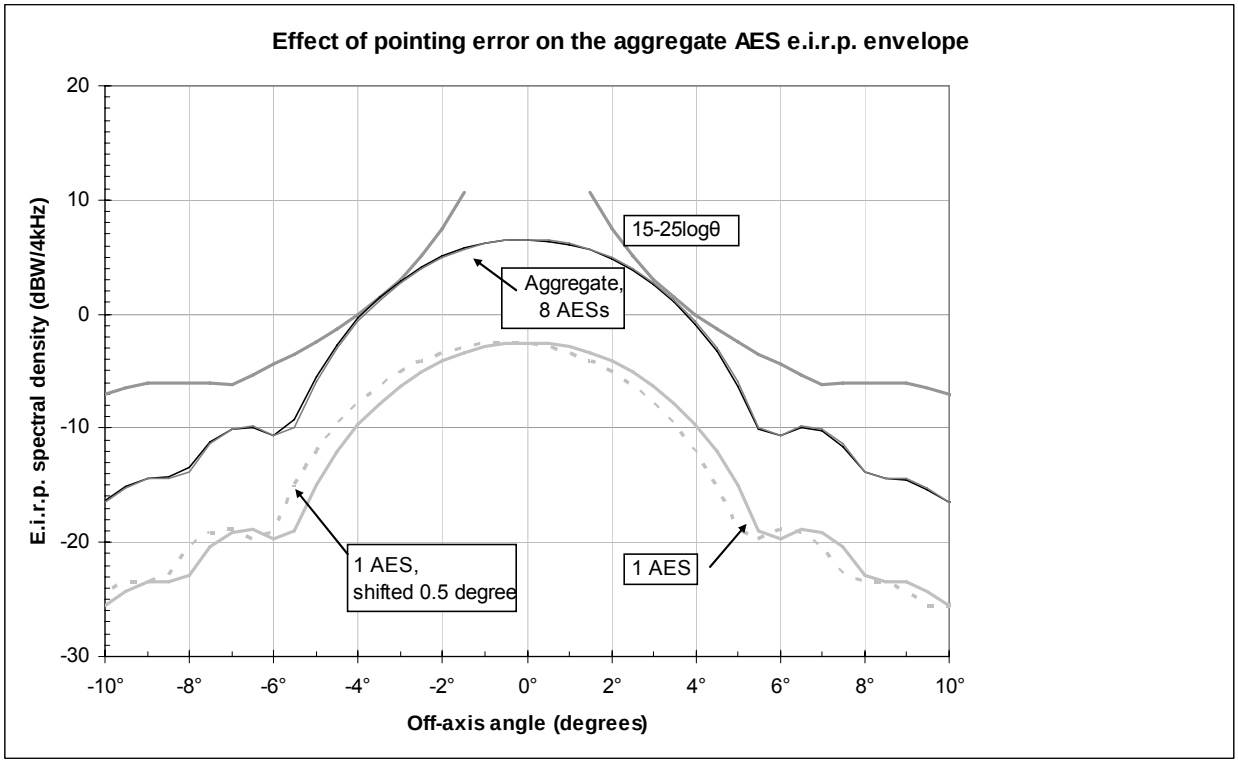
[44] ARINC Comments at 8-9; Boeing Comments at 27. *See also* Recommendation ITU-R M.1643. ITU-R Resolution 902 imposed a 0.2º pointing accuracy requirement on ESVs, but no parallel requirement was adopted at WRC-03 for Ku-band AESs.

[45] ARINC Comments at 9-11; Boeing Comments at 27; ViaSat Comments at 17.

[46] ARINC Comments at Exhibit A, A-1 to A-3.

[47] *Id.* at A-2.

separate curves, one consisting of eight perfectly pointed AESs and the other consisting of seven perfectly pointed AESs and one AES mispointed by 0.5º. A close examination will reveal that there are two curves, but they are so closely aligned that there is no significant difference between them.[48]



[48] The graph reflects a simplification of the process used by Boeing in determining an aggregate off-axis e.i.r.p. density envelope. In actuality, the mispointing of individual antennas is not a constant value but is a random variable and adding these random variables must be done on a statistical basis, rather than simple summation. For example, a single low-power AES has little effect on the aggregate envelope, but if that same AES operates at a higher power as the only AES in a transponder, the mispointing of that single antenna then becomes a much more important factor. The algorithm used by the AMSS operator to calculate the aggregate off-axis e.i.r.p. envelope should take into account random variations of the AES antenna mispointing as well as the e.i.r.p. levels and the statistical effects on the aggregate envelope.

C. Other Operational Requirements

1. Regulation of AMSS Operations Based on Aircraft Country of Registry

As discussed in its initial comments, Boeing recognizes that the Commission must develop AMSS regulations based on aircraft country of registry given potential jurisdictional limitations and international comity concerns.[49] Boeing would emphasize, however, that uniform operating requirements are essential to ensure that all AES operators providing service in the United States are treated equitably and that other services are adequately protected from harmful interference. Such an approach is consistent with U.S. commitments relating to trade in telecommunications services, and would promote non-discriminatory treatment of AMSS systems by regulators around the world.

In particular, the Commission should permit AMSS licensees to provide service to U.S. and foreign-registered aircraft without requiring a network control facility or hub earth station to be located in the United States. As discussed in Boeing's original comments, such an approach would be consistent with the Commission's prior treatment of other MSS services and ESV systems.[50] Requiring a 24/7 point of contact located in the United States with the capability and authority to cease AES transmissions would address any potential interference concerns that may arise, and system-specific agreements or license conditions would ensure that law enforcement and national security concerns are fully satisfied.[51] Thus, there is no basis to require burdensome local network control or hub earth station requirements on either U.S. or foreign AES operations in the United States.

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[49] Boeing Comments at 38-42.

[50] *See id.* at 33-34.

[51] *See* Section II.D, *infra*.

Of course, the Commission should retain full authority to substantively review and authorize all AES operations within U.S. airspace. For this reason, Boeing proposed that AESs on a foreign-registered aircraft be temporarily associated with and licensed to a U.S. AMSS licensee when the AES is operating within U.S. airspace.[52] This is similar to the approach recently adopted by the Commission in the *ESV Order,*[53] and will ensure that U.S. AMSS licensees control foreign-licensed AESs and comply fully with the Commission's technical and operational rules while the AESs operate within U.S. airspace.

It would not be appropriate to permit foreign-registered AES operations in U.S. airspace on an unprotected, non-harmful interference basis under No. 4.4 of the international Radio Regulations,[54] or under any alternative basis that would not include Commission substantive review and authorization of proposed AMSS operations in the United States. Prior Commission review and authorization of AES operations on foreign-registered aircraft is essential to ensure that such operations are conducted in accordance with applicable AMSS rules; that other U.S. policy objectives, such as national security and law enforcement concerns, are satisfied; and that co-frequency services, including government operations, are protected from harmful interference. Thus, the Commission should reject the option of permitting foreign AMSS operation in U.S. airspace under Radio Regulation No. 4.4.

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[52] Petition at 22.

[53] *ESV Order*, 20 FCC Rcd at 724-26 ¶¶ 122-126. Such an approach is also similar to the Commission's treatment of MSS transceivers designed to operate with U.S.-licensed systems, and is appropriate in the context of transborder Ku-band AMSS operations given the global nature of the service. *See* 47 C.F.R. § 25.136(c). *See also Big LEO Report and Order*, 9 FCC Rcd 5936, 6016-17 ¶ 208 (1995) ("[A] roaming user's transceiver operations would fall within the blanket license of the satellite operator or the service vendor."); 47 C.F.R. § 25.135(d).

[54] *NPRM*, 20 FCC Rcd at 2939 ¶ 66. Intelsat Comments at 7-8.

2. AES Tracking Requirements

As discussed in its initial comments, Boeing agrees that Ku-band AMSS operators should be capable of providing AES identification, location information, and spectrum use for interference resolution and enforcement purposes.[55] Accordingly, Boeing supports a requirement for AMSS licensees to maintain tracking information for Ku-band AES operations for a period of up to 90 days to assist in resolving potential interference and compliance issues.[56]

Boeing strongly disagrees, however, that a real-time database of AES tracking information should be made publicly available.[57] Making AES tracking data publicly available raises significant security and privacy concerns. The Commission recognized these concerns in the *ESV Report and Order* and rejected making real-time vessel tracking data publicly available, finding that "risks" associated with such an approach outweighed potential benefits to resolve potential interference.[58] Because the provision of AES tracking data to the public raises the same concerns, the Commission should similarly reject such a requirement in this proceeding.

Third party involvement is also ill-advised and unnecessary to resolve potential interference issues.[59] The Commission's AMSS network control and AES tracking requirements, as well as the satellite industry's exemplary history of promptly addressing harmful interference issues, obviate the need for third party involvement. Providing AES

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[55] Boeing Comments at 36-38.

[56] A data retention period of up to 90 days will provide a clear indication of AES operational patterns to address interference and compliance issues without unduly burdening AMSS licensees. As suggested by ARINC, potential interference concerns may be fully addressed by a shorter data retention period. *See* ARINC Comments at 18 (proposing a 30-day retention period).

[57] *See* Comments of Satellite Users Interference Reduction Group, IB Docket No. 05-20, at 2 (filed July 5, 2005) ("SUIRG Comments").

[58] *ESV Report and Order*, 20 FCC Rcd at 721 ¶ 112 (the Commission agreed "with those commenters who argue that the risk associated with ubiquitous distribution of such tracking information outweighs the benefit it may provide in preventing interference to other operators.").

[59] SUIRG Comments at 2-3.

tracking data to third parties could also raise security issues, harm the growth of the AMSS market, jeopardize contractual obligations and infringe on privacy rights.[60]

Similarly, there is no reason to adopt PanAmSat's proposal to require Ku-band operators provide "passive tracking" information (*i.e.,* comprehensive data on an AMSS licensee's installed base of AESs) to FSS operators on request.[61] PanAmSat contends that passive tracking is necessary to address the hypothetical situation that an AMSS licensee may lose track of an AES terminal, which could subsequently malfunction or unexpectedly resume transmission.[62] PanAmSat's "malfunction scenario" is implausible at best because AES cannot operate without being specifically commanded by its network control facilities. It is likewise far-fetched that AMSS licensees will "lose" AES terminals costing tens or hundreds of thousands of dollars per aircraft. While AMSS licensees will undoubtedly maintain an accurate inventory of AESs, provision of that information to third parties is unduly intrusive and burdensome, and would provide no public benefit. Thus, PanAmSat's call for mandatory provision of "passive tracking" information to FSS operators upon request should be rejected.

D. National Security and Public Safety Concerns

The Department of Justice, including the Federal Bureau of Investigation, and the Department of Homeland Security (collectively "the Departments"), have submitted comments in this proceeding in support of the Commission's efforts to make additional communications options available to passengers, aircraft crew, and law enforcement officers onboard aircraft so

[60] ARINC Comments at 13-16. In the unlikely event that an interference issue arises, an affected party will contact the AMSS licensee or neighboring satellite operators to address the situation. Given AMSS network control and tracking requirements, AMSS licensees can quickly evaluate the situation, determine if the problem originates in its system, and, if so, correct it. There is simply no basis to make real-time AES tracking data publicly available or to provide such data to a third party.

[61] PanAmSat Comments at 5-6.

[62] *Id.*.

long as law enforcement, public safety and national security-related concerns (as well as commercial equities) are adequately addressed. The Departments further state their belief "that the timely roll-out of new commercial airborne communications capabilities can be accomplished in a responsible manner, without unnecessary delay."[63]

Boeing agrees with the Departments' general objectives, including the consideration of "all reasonable remedial measures which may be taken to eliminate or minimize" law enforcement, public safety and national security concerns.[64] Boeing recognizes that the airplane cabin is a unique environment that may present challenges to law enforcement. Indeed, Boeing has maintained an ongoing dialogue with the various concerned law enforcement agencies for a number of years in regard to the development of capabilities to support law enforcement's mission and public safety needs.

Boeing does not believe, however, that adopting rules of general applicability in this proceeding for resolving the Departments' concerns. Instead, Boeing urges the Commission to adopt system-by-system arrangements to meet any Communications Assistance for Law Enforcement Act ("CALEA") related requirements and additional public safety and national security obligations. The Commission has recognized that satellite networks differ from terrestrial networks, as well as from each other, in fundamental ways.[65] The differences arise from system-specific factors including the types of satellites and gateway earth stations used to provide service in the United States. For these reasons, system-by-system arrangements typically have been negotiated between law enforcement and satellite carriers to address specific

[63] *See* Comments of the Department of Justice, including the Federal Bureau of Investigation, and the Department of Homeland Security, IB Docket No. 05-20, at 3-4 ("Departments Comments").

[64] *Id.* at 3.

[65] Communications Assistance for Law Enforcement Act and Broadband Access and Services, *Notice of Proposed Rulemaking and Declaratory Ruling*, 19 FCC Rcd 15676, 15719-20 ¶ 86 (2004) ("*CALEA Broadband Proceeding*").

public safety and national security concerns,[66] including such matters as the location of ground stations.[67] The Commission has indicated, however, that it "will make an independent decision on applications and will evaluate concerns raised by the Executive Branch agencies in light of all the issues raised (and comments in response) in the context of the particular application."[68] A similar approach is warranted for of AMSS systems, particularly given the limited number of such systems and their unique network architectures.

Moreover, the Commission has already noted in this proceeding that it is examining the appropriate legal and policy framework of CALEA, including the applicability of CALEA to

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[66] *See, e.g.,* Space Station System Licensee, Inc., Assignor and Iridium Constellation LLC, Assignee, for Consent to Assignment of License Pursuant to Section 310(d) of the Communications Act, *Memorandum Opinion, Order and Authorization*, 17 FCC Rcd 2271, 2297, Appendix A, ¶ 2.1 (2002). *See also, e.g.,* International Authorizations Granted, IB Docket No. 04-4*, Public Notice,* DA 04-628, at 2-3 (rel. March 8, 2004) (granting the assignment and transfer of control of satellite licenses subject to assumption of agreements previously made with law enforcement agencies); Motient Services Inc. and TMI Communications and Company, LP, Assignors and Mobile Satellite Ventures Subsidiary *LLC*, Assignee*, Order and Authorization,* 16 FCC Rcd 20469, 20480-81 ¶¶ 31-34 (2001).

[67] *See, e.g*., Lockheed Martin Global Telecommunications, Comsat Corporation, and Comsat General Corporation, Assignor and Telenor Satellite Mobile Service, Inc. and Telenor Satellite Inc., Assignee, Applications for Assignment of Section 214 Authorizations, Private Land Mobile Radio Licenses, Experimental Licenses, and Earth Station Licenses and Petition for Declaratory Ruling Pursuant to Section 310(b)(4) of the Communications Act, File No. SES-ASG-20010504-00896, *Order and Authorization*, FCC 01-369, at Appendix B, ¶ 2.2 (2001) (requiring that all domestic communications be transmitted through U.S. earth stations or routed through a point of presence "that includes a network switch or router under the control of" the licensee in the United States).

[68] Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic and International Satellite Service in the United States, *Report and Order*, 12 FCC Rcd 24094, 24171-72 ¶¶ 180-182. (1997) ("*DISCO II*"). *See also* Comsat Corporation d/b/a Comsat Mobile Communications, *Memorandum, Opinion, Order and Authorization,* 16 FCC Rcd 21661, 21708 ¶ 98 (2001) ("We find that SITA has adequately addressed law enforcement and national security concerns. We note that SITA consulted with the Department of Justice (DOJ) and addressed DOJ's concerns. We are including a copy of a letter memorializing those discussions in SITA's license file."); *id.* ¶ 99 ("Likewise, we find that Honeywell has adequately addressed law enforcement and national security concerns. Honeywell also consulted with DOJ and addressed DOJ's concerns. We are including a copy of a letter memorializing those discussions in Honeywell's license file."); *id.* ¶ 100 ("We also note that Stratos stated that it will route all traffic involving U.S. METs through a point of presence in the United States. Under such circumstances, and in the absence of specific allegations of fact regarding national security concerns, we see no reason to impose additional conditions on Stratos' authorizations. As with all Commission licensees, however, we encourage Stratos to work cooperatively and promptly to address law enforcement and national security concerns directly with the expert agencies.").

broadband Internet access services (including those delivered by satellite systems) in the *CALEA Broadband Proceeding*,[69] and that "to the extent any rules are adopted in that proceeding regarding CALEA obligations of satellite-based providers of broadband internet access, we anticipate that AMSS operators might also be subject to such rules."[70] There does not appear to be any pressing need to replicate such efforts in this proceeding, potentially leading to inconsistent and/or conflicting requirements.

Boeing clearly recognizes the importance of developing appropriate capabilities to address law enforcement and national security concerns in the context of providing AMSS services. Cooperation among AMSS licensees, airline carriers, satellite providers, ground station operators, law enforcement and potentially other service providers involved in providing communications capabilities to an aircraft in flight may be required to implement such capabilities. Boeing intends to continue to work with the Departments to reach appropriate understandings in regard to their legitimate law enforcement, public safety and national security requirements. The Commission should conclude that such an approach is superior to the development of rules of general applicability on the public record.

E. Revised Draft AMSS Rules

With its initial comments, Boeing submitted a set of draft AMSS rules patterned after the ESV rules. With these reply comments, Boeing submits a revised set of draft rules to account for a minor typographical error in draft footnote US xxy, use of the 12.5-12.75 GHz frequency band for AMSS space-to-Earth transmissions, and coordination of AES operations at higher off-axis e.i.r.p. density levels. The changes from the initial draft rules submitted with Boeing's comments are noted in redlining.

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[69] *See NPRM*, 20 FCC Rcd at 2908 n.7.

[70] *Id.*

III. CONCLUSION

For the foregoing reasons, Boeing respectfully requests that the Commission adopt AMSS licensing and service rules consistent with these reply comments.

Respectfully submitted,

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Attachment A

Revised Draft Rules for the Aeronautical Mobile-Satellite Service

Attachment A

Revised Draft Rules for the
Aeronautical Mobile-Satellite Service

§ 2.106 Table of Frequency Allocations.

Revise the table to include the following footnotes

* * * * *

FEDERAL GOVERNMENT (US) FOOTNOTES

* * * * *

USxxx In the band 14.0-14.5 GHz, operations of Aeronautical Mobile-Satellite Service earth stations are subject to coordination with NTIA in order to minimize interference to NASA's Tracking and Data Relay Satellite System (TDRSS) earth stations in operation before [effective date of rule]. For other TDRSS earth stations, the operations of Aeronautical Mobile-Satellite Service earth stations in the 14.0-14.2 GHz are subject to such coordination.

USxxy In the band 14.~~0~~47-14.~~47~~ 5 GHz, operations of Aeronautical Mobile-Satellite Service earth stations are subject to coordination with NTIA in order to minimize interference to the radio astronomy sites that observe in the 14.47-14.5 GHz band

* * * * *

NON-FEDERAL GOVERNMENT (NG) FOOTNOTES

* * * * *

NGyyy In the bands 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space), aircraft earth stations in the aeronautical mobile-satellite service are an application of the Fixed-Satellite Service (FSS). The provisions of ITU Radio Regulations Nos. 5.29, 5.30 and 5.31[1] apply, except that reception from geostationary space stations in the fixed-satellite service in the 11.7-12.2 GHz shall be protected in the United States on a primary basis, provided that the aircraft earth stations operate under the same parameters as earth stations in the fixed-satellite service.

[1] ITU Radio Regulations Nos. 5.29. 5.30, 5.31 state that stations of a secondary service:

5.29 a) shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date;

5.30 b) cannot claim protection from harmful interference from stations of a primary service to which frequencies are already assigned or may be assigned at a later date;

5.31 c) can claim protection, however, from harmful interference from stations of the same or other secondary service(s) to which frequencies may be assigned at a later date.

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§ 25.115 Application for earth station authorizations.

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(a)(2)(iii) The earth station is not an ESV or a Ku-band AES.
*****

§ 25.130 Filing requirements for transmitting earth stations.

(a) Applications for a new or modified transmitting earth station facility shall be submitted on FCC Form 312, and associated Schedule B, accompanied by any required exhibits, except for those earth station applications filed on FCC Form 312EZ pursuant to § 25.115(a)…. All such earth station license applications must be filed electronically through the International Bureau Filing System (IBFS) in accordance with the applicable provisions of part 1, subpart Y of this chapter. Additional filing requirements for Earth Stations on Vessels are described in §§ 25.221 and 25.222 of this part. Additional filing requirements for AESs transmitting in the Ku-band are described in §§ 25.223 of this part. In addition, applicants not required to submit applications on Form 312EZ, other than ESV or AES applicants, must submit the following information to be used as an "informative" in the public notice issued under § 25.151 as an attachment to their application:

* * * * *

§ 25.220 Non-conforming transmit/receive earth station operations.

(a)(1) This section applies to earth station applications, other than ESV or AES applications, in which:

(i) The proposed antenna does not conform to the standards of §§25.209(a) and (b), and/or

(ii) The proposed power density levels are in excess of those specified in §25.134, §25.211, or §25.212, or those derived by the procedure set forth in paragraph (c)(1) of this section, whichever is applicable.

§ 25.202 Frequencies, frequency tolerance and emission limitations.

* * * * *

(a)(9) The following frequencies are available for use by aircraft earth stations (AESs):

10.95-11.2 GHz (space-to-Earth)
11.45-11.7 GHz (space-to-Earth)

11.7-12.2 GHz (space-to-Earth)
12.5-12.75 GHz (space-to-Earth)
14.0-14.5 GHz (Earth-to-space)

AESs shall be authorized and coordinated as set forth in § 25.223 of this chapter.

§ 25.203 Choice of sites and frequencies.

(a) Sites and frequencies for earth stations, other than ESVs and AESs, operating in frequency bands shared with equal rights between terrestrial and space services, shall be selected, to the extent practicable, in areas where the surrounding terrain and existing frequency usage are such as to minimize the possibility of harmful interference between the sharing services.

(b) An applicant for an earth station authorization, other than an ESV and AESs, in a frequency band shared with equal rights with terrestrial microwave services shall compute the great circle coordination distance contour(s) for the proposed station in accordance with the procedures set forth in § 25.251.

* * * * *

(c) Prior to the filing of its application, an applicant for operation of an earth station, other than an ESV or AES, shall coordinate the proposed frequency usage with existing terrestrial users and with applicants for terrestrial station authorizations with previously filed applications in accordance with the following procedure:

* * * * *

(d) An applicant for operation of an earth station, other than an ESV or AES, shall also ascertain whether the great circle coordination distance contours and rain scatter coordination distance contours, computed for those values of parameters indicated in § 25.251 (Appendix 7 of the ITU RR) for international coordination, cross the boundaries of another Administration. In this case, the applicant shall furnish the Commission copies of these contours on maps drawn to appropriate scale for use by the Commission in effecting coordination of the proposed earth station with the Administration(s) affected.

* * * * *

(k) An applicant for operation of an earth station, other than an ESV or AES, that will operate with a geostationary satellite or non-geostationary satellite in a shared frequency band in which the non-geostationary system is (or is proposed to be) licensed for feeder links, shall demonstrate in its applications that its proposed earth station will not cause unacceptable interference to any other satellite network that is authorized to operate in the same frequency band, or certify that the operations of its earth station shall conform to established coordination agreements between the operator(s) of the space station(s) with which the earth station is to communicate and the operator(s) of any other space station licensed to use the band.

§ 25.205 Minimum angle of antenna elevation.

c) For AESs in flight, there is no minimum angle of elevation. For AESs operating on the ground, the minimum angle of elevation shall be 5 degrees.

§ 25.223 Blanket Licensing provisions for Aircraft Earth Stations (AESs) receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) frequency bands and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band, operating with Geostationary Satellites in the Fixed-Satellite Service.

(a) All applications for licenses for AESs receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth) frequency bands, and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band, to geostationary satellites in the fixed-satellite service shall provide sufficient data to demonstrate that the AES operations meet the following criteria, which are ongoing requirements that govern all AES licensees and operations in these bands:

(1) The off-axis EIRP spectral density for co-polarized signals, emitted from the AES in the plane of the geostationary satellite orbit as it appears at the particular earth station location (*i.e.*, the plane determined by the focal point of the antenna and the line tangent to the arc of the geostationary satellite orbit at the position of the target satellite), shall not exceed the following values:

$15 - 25\log(\theta)$ dBW/4kHz	for	$1.5°^* \leq \theta \leq 7.0°$
-6 dBW/4kHz	for	$7.0° < \theta \leq 9.2°$
$18 - 25\log(\theta)$ dBW/4kHz	for	$9.2° < \theta \leq 48°$
-24 dBW/4kHz	for	$48° < \theta \leq 85°$
-14 dBW/4kHz	for	$85° < \theta \leq 180°$

where θ is the angle in degrees from the axis of the main lobe.
* If the AES antenna pointing error is taken into account by the network control facility in controlling the off-axis EIRP density, the above pattern starts at 2° instead of 1.5°.

For the purposes of this section, the peak EIRP of an individual sidelobe may not exceed the envelope defined above for θ between 1.5° and 7.0°. For θ greater than 7.0°, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the envelope given above by more than 3 dB.

(2) For networks in which two or more earth stations can transmit simultaneously on the same frequency, the envelopes in (1) above apply to the aggregate emissions of the earth stations.

(3) The aggregate off-axis EIRP shall not exceed the envelope in (1) above by more than the amounts set forth in the following Table, with the maximum duration of any single exceedance being less than 100 milliseconds.

Percentage of Time*	Increase in Aggregate EIRP Allowed
10% (10^{-1})	0 dB
1% (10^{-2})	2 dB
0.1% (10^{-3})	4 dB
0.01% (10^{-4})	6 dB
0.001% (10^{-5})	8 dB
0.0001% (10^{-6})	10 dB
0.00001% (10^{-7})	12 dB
0.000001% (10^{-8})	14 dB
0.0000001% (10^{-9})	16 dB

*The time interval over which the percentage of time is averaged shall be 1 month.

(4) For non-circular AES antennas, the alignment of the major axis of the antenna with respect to the tangent to the geostationary satellite orbital arc at the target satellite point will be taken into account in controlling the AES aggregate EIRP to meet the specified off-axis EIRP criteria.

(5) AES operations at levels higher than the limits given in (1) above may be authorized if the AMSS applicant provides certification from the satellite operator that the levels are consistent with the satellite's coordination agreements. ~~Such an authorization shall not prejudice coordinations with future FSS licensees.~~ Licensees authorized under this paragraph shall bear the burden of coordinating with future applicants or licensees whose proposed compliant operations at 6 degrees or smaller orbital spacing are potentially or actually adversely affected by the operation of the non-compliant licensee. If no good faith agreement can be reached, however, the non-compliant licensee shall reduce its AES power density levels to be compliant within those specified in (1) above.

(6) All applications for AESs shall provide information demonstrating that it has accounted for the following factors in the design, coordination and operation of an AES:

i. Mis-pointing of AES antennas.
ii. Variations in the antenna pattern of AES.
iii. Variations in the transmit e.i.r.p. density from AES.
iv. Contention access protocol.

(7) Other technical requirements

i. AES terminals that use closed loop tracking[2] of the satellite signal need to employ an algorithm that is resistant to capturing and tracking adjacent satellite signals.
ii. AES terminals should be subject to the monitoring and control of a NCMC or equivalent facility.
iii. AES terminals need also to be self-monitoring and if an individual AES detects a fault which can cause harmful interference to FSS networks, the AES must automatically mute its transmissions until the cause of harmful interference has been remedied.

(8) There shall be a point of contact in the United States, with phone number and address included with the application, available 24 hours a day, seven days a week, with authority and ability to cease all emissions from the AESs.

(9) AESs that exceed the radiation guidelines of Section 1.1310 Radiofrequency radiation exposure limits must provide, with their environmental assessment, a plan for mitigation of radiation exposure to the extent required to meet those guidelines.

(10) There shall be an exhibit included with the application describing the geographic area(s) in which the AESs will operate.

(b) Applications for AES operation in the 14.0-14.5 GHz (Earth-to-space) with geostationary satellites in the fixed-satellite service must include, in addition to the particulars of operation identified on Form 312 and associated Schedule B, the following data for each AES antenna type:

(1) A series of EIRP density charts or tables, calculated for a production earth station antenna, based on measurements taken on a calibrated antenna range at 14.25 GHz, with the off-axis EIRP envelope set forth in paragraphs (a)(1) through (a)(3) of this Section superimposed, as follows:

(i) showing off-axis co-polarized EIRP spectral density in the azimuth plane, for off-axis angles from minus 10° to plus 10°and from minus 180° to plus 180°.
(ii) showing off-axis co-polarized EIRP spectral density in the elevation plane, at off-axis angles from 0° to plus 30°.
(iii) showing off-axis cross-polarized EIRP spectral density in the azimuth plane, at off-axis angles from minus 10° to plus 10°.
(iv) showing off-axis cross-polarized EIRP spectral density in the elevation plane, at off-axis angles from minus 10° to plus 10°.

Or

[2] Closed loop logic is deployed to overcome various faults that may cause unintended satellite tracking. In closed loop systems a feedback is used to see if the desired tracking has taken place by measuring the difference between the input and output signals and the corrective action takes place as the result of comparison.

(2) A series of gain charts or tables, for a production earth station antenna, measured on a calibrated antenna range at 14.25 GHz, with the earth station antenna gain envelope set forth in Section 25.209(a) and b superimposed, for the same planes and ranges enumerated in paragraphs (b)(1)(i) through (b)(1)(iv) of this Section, that, combined with input power density entered in schedule B, demonstrates that off-axis EIRP spectral density envelope set forth in paragraphs (a)(1) through (a)(3) of this Section will be met.

Or

(3) A certification that the AES antenna conforms to the gain pattern criteria of 25.209(a) and (b), that, combined with input power density entered in Schedule B, demonstrates that the off-axis EIRP spectral density envelope set forth in paragraphs (a)(1) through (a)(3) of this Section will be met.

(c) AESs receiving in the 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth) frequency bands, and transmitting in the 14.0-14.5 GHz (Earth-to-space) frequency band, shall operate with the following provisions:

(1) For each AES transmitter, a record of the aircraft location (*i.e.*, latitude/longitude), transmit frequency, channel bandwidth and satellite used shall be time annotated and maintained for a period of not less than 90 days. Records will be recorded at time intervals no greater than every 5 minutes while the AES is transmitting. The AES operator will use this data to analyze instances of reported interference and will make this data available upon request to NTIA or the Commission within 24 hours of the request.

(2) AES operators communicating with aircraft of foreign registry must maintain detailed information on each aircraft's country of registry and a point of contact for the relevant administration responsible for licensing AESs.

(3) AES operators shall control all AESs by a hub earth station located in the United States, except that an AES may operate under control of a hub earth station location outside the United States provided the AES operator maintains a point of contact within the United States that will have the capability and authority to cause an AES to cease transmitting if necessary.

(d) Operations of AESs in the 14.0-14.~~2~~25 GHz (Earth-to-space) frequency band within line-of-sight of the NASA TDRSS facilities on Guam (located at latitude: 13° 36' 55" N, longitude 144° 51' 22" E) or White Sands, New Mexico (latitude: 32° 20' 59" N, longitude 106° 36' 31" W and latitude: 32° 32' 40" N, longitude 106° 36' 48"W) are subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC). When NTIA seeks to provide similar protection to future TDRSS sites that have been coordinated through the IRAC Frequency Assignment Subcommittee process, NTIA will notify the Commission at least six months prior to initial operational status. Upon public notice from the Commission, all AES operators must cease operations in the 14.0-14.2 GHz band within line-of-sight of the new TDRSS site until after NTIA/IRAC coordination for the new TDRSS facility is complete. AES operations will then again be permitted to operate in the 14.0-

14.2 GHz band within line-of-sight of the new TDRSS site, subject to any operational constraints developed in the coordination process.

(e) Operations of AESs in the 14.47-14.5 GHz band are also subject to coordination through the National Telecommunications and Information Administration (NTIA) Interdepartment Radio Advisory Committee (IRAC) to minimize interference into radio astronomy service sites that observe in the 14.47-14.5 GHz band.

(f) In the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth) frequency bands AESs shall not claim protection from interference from any authorized terrestrial stations to which frequencies are either already assigned, or may be assigned in the future.

(g) Operations of AESs on U.S.-registered aircraft in the 14.0-14.5 GHz frequency band within line-of-sight of the territory of a foreign administration where fixed service networks have primary allocation in this band shall comply with the maximum power flux density (pfd) requirements of the most recent version of Recommendation ITU-R M.1643, unless the AMSS operator has obtained an agreement with that administration to permit operations at higher pfd levels.

(h) Prior to operations within a foreign nation's airspace, operators of AESs on U.S.-registered aircraft shall ascertain whether the relevant administration has operations that could be affected by AES terminals and determine whether that administration has adopted specific requirements concerning AES operations. Once the aircraft enters foreign airspace, AES operations shall comply with the Commission's rules or those of the foreign administration, which ever are more constraining.

(i) AES operators seeking to operate on a U.S.-registered aircraft over international waters or in foreign airspace shall certify that the operator(s) of all satellites to be accessed have confirmed that the proposed AES operations would be within the coordinated parameters of the satellite.

(j) The holder of an AES blanket license or AMSS hub earth station authorization operating AESs on foreign-registered aircraft in the United States shall be responsible for ensuring that the operations of the AES terminals comply with all applicable FCC rules.

(k) No later than 60 days prior to commencing commercial operations, the holder of an AES blanket license or AMSS hub earth station authorization shall submit a report verifying its ability to comply with the requirements of this Section 25.223, and include test results and a description of any design modifications[3] or operational procedures necessary to ensure that these conditions are met. The report shall, *inter alia*, address the following factors regarding the aggregate off-axis EIRP levels generated by the AESs:

[3] ~~*But see* 47 C.F.R. §§ 25.117 (modification of station license), 25.118 (modification not requiring prior authorization).~~

(1) variations in aggregate off-axis EIRP caused by mis-pointing of AES antennas (this includes, at a minimum, effects caused by bias and latency of their ~~AMSS mobile terminal~~ antenna pointing systems, tracking error of closed loop tracking systems, and misalignment between transmit and receive apertures);

(2) variations in aggregate off-axis EIRP caused by variations in the AES antenna pattern (this includes, at a minimum, effects caused by manufacturing tolerances, aging of the antenna, and environmental effects, variation in antenna pattern with scan angles, element phase error, amplitude error, and failure rate); and

(3) variations in aggregate off-axis EIRP caused by variations in AES transmit power (this includes, at a minimum, effects caused by measurement error, control error, and latency for closed loop power control systems).

§ 25.271 Control of transmitting stations.

* * * * *

(b) The licensee of a transmitting earth station, other than an ESV or AES, licensed under this part shall ensure that a trained operator is present on the earth station site, or at a designated remote control point for the earth station, at all times that transmissions are being conducted. No operator's license is required for a person to operate or perform maintenance on facilities authorized under this part.

(c) Authority will be granted to operate a transmitting earth station, other than an ESV or AES, by remote control only on the conditions that:

* * * * *

(g) Rules for control of transmitting AESs are provided in § 25.223.